

(12) **UK Patent Application** (19) **GB** (11) **2 244 092 A** (13)  
(43) Date of A publication 20.11.1991

(21) Application No 9011103.0

(22) Date of filing 17.05.1990

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(51) INT CL<sup>5</sup>  
**E05F 3/10**

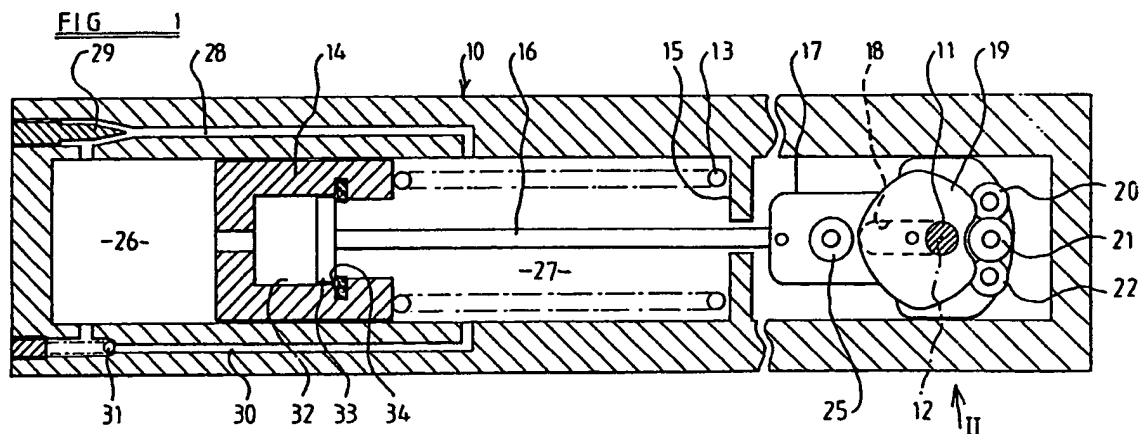
(52) UK CL (Edition K)  
**E2M M11F2 M12E1A M12E1B M12E1C M12F1A  
M16**

(56) Documents cited  
**GB 1582680 A**

(58) Field of search  
**UK CL (Edition K) E2M  
INT CL<sup>5</sup> E05F**

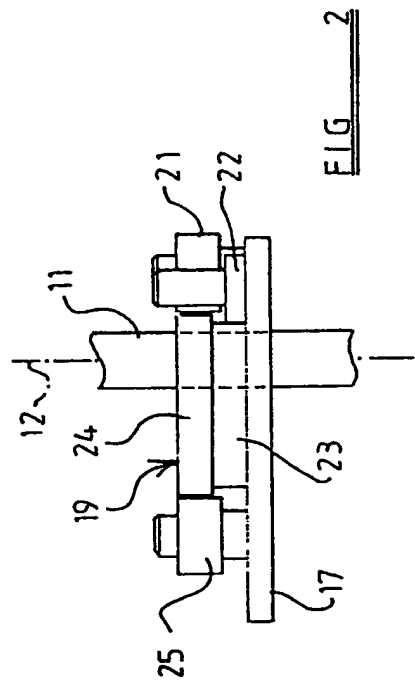
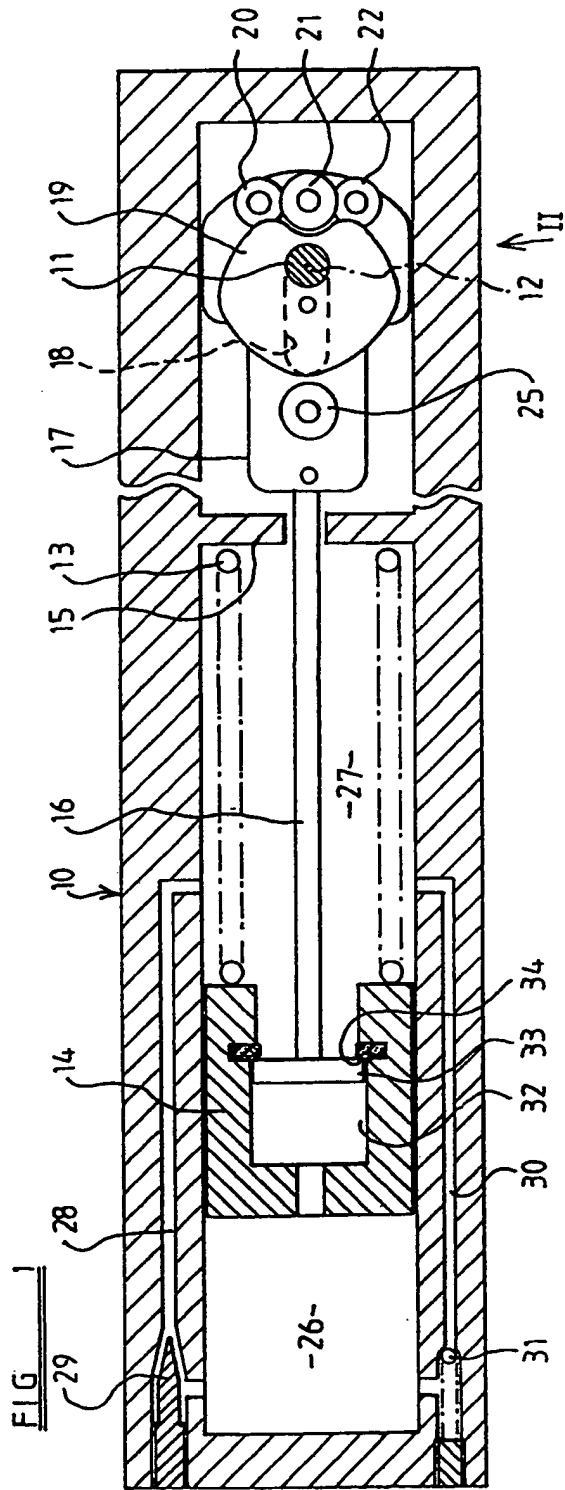
(54) **Door closer**

(57) A door closer comprises external shaft 11 connectable to a door or frame, a cam 19 having two cam faces and rotatable with the shaft, and cam followers 20, 21, 22 mounted on carrier 17 reciprocable with damping piston 14 which is acted on by return spring 13. In the door-closed position shown, followers 20, 22 coact with a flat portion of one cam face, while follower 21 clears a second cam face. Up to 90° of door opening, follower 21 and one of the other followers coact with their respective cam faces. From 90° to near 180° opening, only follower 21 coacts with its cam face. Follower 25 coacts with the same cam face as follower 21.



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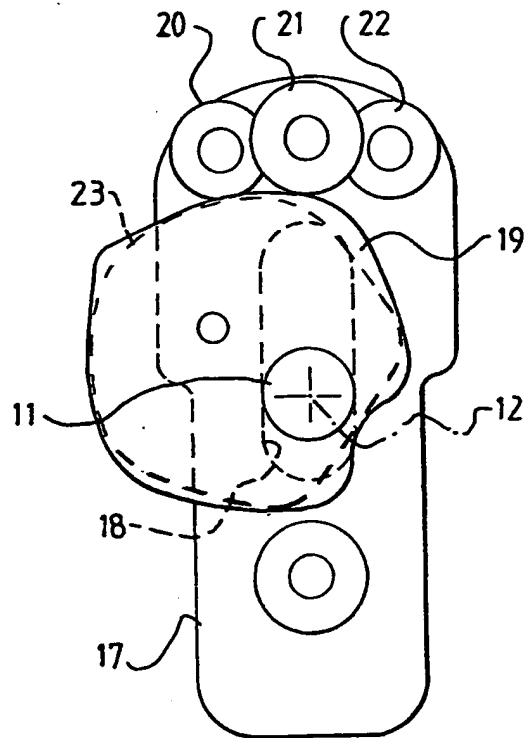


FIG 3

Title: Door-Closing Device

**Description of Invention**

The present invention relates to a device suitable for closing a door and comprising a hollow housing, an operating element accessible from outside the housing and movable relative to the housing, a spring disposed inside the housing and transmitting means for transmitting motion between the spring and the operating element. In use, one of the housing and the operating element is anchored on the door or another movable closure member and the other of the housing and the operating element is anchored with respect to a fixed structure, for example a floor or a frame defining an opening which is closed by the door. Opening movement of the door is transmitted to the spring to stress the spring and thereby store energy in the spring. When the door is released, that energy is expended in closing the door.

The invention is applicable with a special advantage to a device for use in association with a door which can be opened by movement in either of two opposite directions from a closed position. A device for use with such a door may be required to permit movement of the door through an angle approaching 360°. It is also desirable that the closing device should define within close limits the closed position of the door and should oppose any movement from that position with a substantial force.

According to a first aspect of the present invention, the transmitting means of a device of the kind described is characterised by a carrier guided for reciprocation along a path inside the housing, three cam followers mounted in a row on the carrier and a cam having a first cam face for cooperation with a pair of said followers at the ends of the row and a second cam face for cooperation with the intermediate follower.

An example of a door closer embodying the present invention will now be described, with reference to the accompanying drawing, wherein

**FIGURE 1** shows a cross section through a door-closing device, partly

in a plane containing a longitudinal axis of a piston of the device and partly in another plane parallel to that axis,

**FIGURE 2** shows a cam and follower mechanism of the device, as viewed in the direction indicated by the arrow II in Figure 1 and

**FIGURE 3** is a view of the cam and follower mechanism similar to that of Figure 1 but showing the mechanism with a cam displaced from a datum position represented in Figure 1.

The device illustrated in Figures 1 and 2 comprises a hollow, elongated housing 10 and a shaft 11 which is mounted in the housing near to one end thereof for turning relative to the housing about a longitudinal axis 12 of the shaft, which axis is perpendicular to the length of the housing. The housing is provided with bearings (not shown) for supporting the shaft. The shaft protrudes through at least one of these bearings to the outside of the housing and there is associated with this bearing a seal to prevent escape of oil from inside the housing. The shaft 11 constitutes an operating element of the device and, when the device is in use, is connected with a door or other movable closure member. The door may be mounted for pivoting about the axis 12, in which case the protruding part of the shaft may constitute a pivot for the door. The protruding part of the shaft or an adaptor mounted thereon may be received in a socket formed in the door. Alternatively, the protruding part of the shaft may be connected with the door by means of a bracket. Alternatively, the pivot axis of the door may be offset from the axis 12, in which case the shaft is connected with the door by a suitable linkage. When the device is in use, the housing 10 is mounted in or on a fixed structure, for example a floor or a frame of the door or other closure member.

It would also be within the scope of the invention to mount the housing 10 on the door and to connect the protruding portion of the shaft 11 with a frame or other fixed structure by means of a suitable linkage.

There is disposed inside the housing 10 a spring 13 for storing energy when the door or other associated closure member is opened, so that the stored energy can subsequently be used for closing the door. The device further comprises transmitting means for transmitting motion between the spring and the

shaft 12 both when the door is being opened and when the door is being closed by the spring. The transmitting means includes a piston 14 for damping movement of the shaft 11 under the action of the spring 13 so that the speed at which the door is closed is restricted. The piston reciprocates in a cylindrical bore defined by the housing 10, this bore being closed at an end of the housing remote from the shaft 11 by a plug and communicating at its other end with a non-cylindrical space inside the housing.

In the example illustrated in Figure 1, the spring 13 bears directly on the piston 14 and on an abutment 15 formed at the inside of the housing 10. The spring 13 is a coiled compression spring and is substantially cylindrical. The piston has a rod 16 extending along the interior of the spring to a mechanism for converting reciprocation of the piston to rotary motion of the shaft 11. In the particular example illustrated, this mechanism is a cam and follower mechanism. However, it would be within the scope of the invention for other mechanisms having a similar function to be used, for example a rack and pinion mechanism or a crank mechanism. The cam and follower mechanism of the device illustrated in Figure 1 provides for turning of the shaft 11 from a datum position in either direction through an angle approaching  $180^\circ$ , provides a well-defined datum position and permits the shaft 11 to be disposed near to an end of the housing 10.

The piston rod 16 is connected adjacent to an end thereof remote from the piston 14 with a carrier 17 which is guided for reciprocation inside the housing 10 along a path which is perpendicular to the axis 12. An elongated aperture 18 is formed in the carrier and the shaft 11 extends through this aperture with sliding clearance. On the carrier, there are mounted a number of followers for cooperation with a cam 19 provided on the shaft 11. The cam has two cam faces, both of which face away from the axis 12 and which lie at different positions along that axis.

There is on the carrier 17 adjacent to an end thereof remote from the piston rod 16 a group of three cam followers 20, 21 and 22 respectively. Each follower is mounted rotatably on a respective stub which is fixed with respect to the carrier 17. The stubs are arranged in a curved row on the follower. The

followers 20 and 22 at opposite ends of the row cooperate with a first of the cam faces 23. The follower 21, which lies between the followers 20 and 22, is arranged to cooperate with the second cam face 24.

The spring 13 normally urges one or more of the followers, 20, 21 and 22 against the cam 19. To ensure that the followers do not move away from the cam, there may be provided on the carrier 17 an additional follower 25 which lies at the side of the axis 12 remote from the cam follower 21 and which cooperates with the second cam face 24.

The carrier 17 is urged by the spring 13 to the datum position shown in Figure 1. When the carrier is in this position, the followers 20 and 22 both bear on at least approximately flat portion of the first cam face 23. Since the followers 20 and 22 are spaced equally from the piston 14, they hold the cam 19 and therefore the shaft 11 in a datum position. This position corresponds to the closed position of the door controlled by the device. The respective positions where the followers 20 and 22 bear on the cam face 23 are spaced well apart and this ensures that the datum position is well-defined. Turning of the cam 19 through an angle of only one or two degrees from the datum position is opposed by the spring.

When the cam 19 is in the datum position, there is a clearance between the follower 21 and the second cam face 24. As the cam 19 is turned in either direction, relative to the housing 10, for example by opening of the associated door, the cam face 24 moves into contact with the follower 21. Through a substantial range of angular movement, for example  $60^\circ$  or more, the cam 19 acts on two three of the followers 20, 21 and 22 to drive the carrier 17 along the housing 10 and thereby compress the spring 13.

Over an initial range of movement, for example up to approximately  $90^\circ$  from the datum position, the device provides an approximately uniform force opposing opening movement of the door. The cam faces 23 and 24 are formed to provide a significantly greater force opposing opening movement of the door as the cam 19 completes  $90^\circ$  of movement from the datum position.

If movement of the cam 19 is continued beyond  $90^\circ$  from the datum position, then the action of the cam face 24 on the follower 21 moves the carrier

17 sufficiently far for one of the followers 20 and 22 to move out of contact with the cam face 23 (the other of the followers 20 and 22 being already out of contact). Movement of the cam 19 and shaft 11 can continue until almost 180° of movement has been completed from the datum position. The shaft can be turned in either direction from the datum position so that the permitted range of movement is approximately 360°.

If the associated door is released, the spring 13 extends to drive the piston 14 and the carrier 17 along the housing 10 so that the cam followers drive the cam 19 around the axis 12 towards the datum position. In order to limit the speed at which the shaft is turned back to the datum position, the interior of the housing 10 is charged with an hydraulic fluid which must be displaced, in order for the piston to travel along the housing. One or more passages is provided to permit hydraulic fluid to flow from a chamber 26 inside the housing at the pressure side of the piston to the chamber 27 inside the housing at the opposite side of the piston. By way of example, there is represented a passage 28 formed in the wall of the housing 10 and an adjustable needle valve 29 for controlling flow of hydraulic fluid along the passage. It will be understood that other, known arrangements for permitting controlled flow of hydraulic fluid may be incorporated in the device and these may include one or more passages in the piston or extending through the piston.

To permit substantially unimpeded flow of hydraulic fluid from the chamber 27 to the chamber 26, during opening of an associated door, there is provided a further passage 30 containing a non-return valve 31. By way of example, the passage 30 is shown in the wall of the housing 10 but this passage also could be provided in the piston.

A third passage 32 extends through the piston 14 from the pressure chamber 26 to the chamber 27. The passage 32 is normally closed by a valve element 33 which bears on a valve seat 34 provided in the piston. The valve seat may be formed of a resiliently flexible material to facilitate sealing of the passage 32 by the valve element 33. The valve element 33 is formed integrally with or is rigidly mounted on the piston rod 16 so that the seat 34 is urged onto the valve element 33 by the spring 13. Throughout normal operation of the device,

the passage 32 remains closed.

In the event of an associated door being forced from an open position towards a closed position violently, the torque exerted on the shaft 11 by the door may drive the carrier 17 and the piston 14 to the left, as viewed in figure 1, so rapidly that there is established in the chamber 26 a pressure which is sufficiently great to overcome the action of the spring 13. In this event, the spring fails to hold the seat 34 in engagement with the valve element 33 and the valve element is driven towards the left, as viewed in Figure 1, relative to the piston. This opens the passage 32 for flow of hydraulic fluid directly through the piston from the chamber 26 to the chamber 27 and thereby avoids the device being damaged by the application of excessive torque to the shaft 11. It will be understood that a person exerting force on a marginal portion of a door remote from its pivot axis can exert an extremely high torque on the shaft 11.

The arrangement limits the pressure which can be established in the chamber 26. The exact value of the limiting pressure will depend upon the degree of extension of the spring 13 and will vary during travel of the piston.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

## CLAIMS

1. A door-closing device comprising a hollow housing, an operating element accessible from outside the housing and movable relative to the housing, a spring and transmitting means for transmitting motion between the spring and the operating element, characterised in that the transmitting means comprises a carrier guided for reciprocation along a path inside the housing, three cam followers mounted in a row on the carrier and a cam having a first cam face for cooperation with a pair of said followers at the ends of the row and a second cam face for cooperation with the intermediate follower.
2. A device according to Claim 1 wherein, when the carrier is in a datum position at one end of its path of travel, the followers of said pair are engaged with the first cam face and there is a clearance space between the cam and the intermediate follower.
3. A device according to Claim 2 wherein, as the carrier approaches an end of its path of travel opposite to the datum position, the intermediate follower is engaged with the second cam face and there are clearance spaces between the cam and said followers of the pair.
4. A device according to Claim 3 wherein, when the carrier is in each of a number of intermediate positions, the first face of the cam bears on one of the followers of said pair and the second face of the cam bears on the intermediate follower.
5. A device according to any preceding claim wherein said row is arranged with its length transverse to the length of the path of the carrier.
6. A device according to any preceding claim wherein the row is non-rectilinear.

7. A device according to any preceding claim wherein a fourth follower is mounted on the carrier at a position spaced from an axis of rotation of the cam in a direction opposite to that in which the intermediate follower is spaced.
8. A device according to any preceding claim wherein a portion of the first face which is engaged by the followers of said pair when the carrier is in the datum position is substantially flat.
9. A device according to any preceding claim wherein, at least when the carrier is at one end of its path of travel, the respective positions at which the cam contacts the followers of said pair are spaced apart by a distance which exceeds the travel of the carrier relative to the housing.
10. A device substantially as hereindescribed with reference to and as shown in the accompanying drawings.
11. Any novel feature or novel combination of features disclosed herein or in the accompanying drawings.

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